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(54) ACOUSTIC ISOLATOR FOR A DOWNHOLE TOOL

AKUSTISCHER ISOLATOR FÜR EIN BOHRLOCHWERKZEUG

ISOLANT ACOUSTIQUE POUR OUTIL DE FOND DE TROU

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Description

BACKGROUND OF THE INVENTION

1. Field of Invention

[0001] The present disclosure relates in general to a system for use in imaging a subterranean borehole. More specifically, the present disclosure relates to a downhole imaging system having an acoustic isolator for attenuating acoustic signals in the system.

2. Description of Prior Art

[0002] US 3 982 606 A discloses an acoustical logging apparatus having a signal interference means comprising a rotating sleeve with signal attenuation elements mounted thereon which extend to the wall of the borehole to act as a centralizer when in the borehole. US 2005/167101 A discloses an acoustic isolator comprising mechanical mass-spring systems. US 4 446 539 A discloses a sonic logging tool which includes a relatively short sonic wave isolation section, having interlocking ends having serpentine edges which are spaced from each other, but which are interlocked for preventing longitudinal separation of the two ends, and a damping material disposed between the spatially separated serpentine edges.

[0003] Geological data concerning subterranean formations is often gathered with an imaging technique. The data obtained usually relates to formation resistivity, formation porosity and/or permeability, identification of formation strata and the like. Zones of entrained hydrocarbons and reservoir production capabilities can be determined using this data. Often, the imaging is obtained with a downhole logging tool, which is deployed into a well that extends into the subterranean formation. Example downhole tools for imaging include resistivity tools, nuclear magnetic resonance (NMR) devices, and acoustic sensors. Resistivity tools usually include electrodes on one portion of the tool that are energized to emit a current into the formation, which is measured with sensors on another part of the tool. NMR devices release radiation that scatters from the formation, which is analyzed for assessing formation details. Similar to radiation devices, acoustic devices analyze acoustic data that reflects from the formation. Acoustic imaging tools though are susceptible to erroneous readings when the acoustic signals travel from the transmitter along the tool housing and directly to receivers in the tool.

SUMMARY OF THE INVENTION

[0004] Disclosed herein is an acoustic tool for imaging in a subterranean wellbore that includes an acoustic transmitter, an acoustic receiver spaced axially away from the transmitter, and an elongate attenuation element that is between the transmitter and receiver. The attenuation element includes an end that is spherically shaped, and that is inserted into an open end of a sleeve. A communication path is defined by a transmission of acoustic signals between the transmitter and receiver, and a lock ring contacts the end of the attenuation element. Further, a contact interface between the lock ring and the attenuation element, which follows a curved route, is in the communication path and defines a reduction in cross sectional area of the communication path. In an example, the end of the attenuation element has a first end and a second end that is rounded and inserted into an open end of a sleeve. This example of the tool further includes a multiplicity of attenuation elements, a multiplicity of sleeves and lock rings for coupling the attenuation element in series, and thereby forming a multiplicity of contact interfaces that each attenuate acoustic signals that propagate along the communication path. The tool may further include an oil filled tube inserted into a bore that extends axially through each of the attenuation elements, and lines in the tube that selectively couple with the transmitter and receiver. Optionally, the lock ring spaces the sleeve radially away from the attenuation element.

BRIEF DESCRIPTION OF DRAWINGS

[0005] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is side partial sectional view of an example of a logging tool in a wellbore and having an acoustic isolator and in accordance with the present invention.
FIG. 2 is a side sectional view of an example of the acoustic isolator of Figure 1 and in accordance with the present invention.
FIG. 3 is a perspective view of an example of an attenuation element for use with the acoustic isolator of Figure 2 and in accordance with the present invention.
FIG. 4 is a perspective view of an example of a sleeve for use with the acoustic isolator of Figure 2 and in accordance with the present invention.
FIG. 5 is a perspective view of an example of a lock ring for use with the acoustic isolator of Figure 2 and in accordance with the present invention.
FIG. 6 is a perspective view of an example of the acoustic isolator of Figure 2 and in accordance with the present invention.

[0006] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the scope of the invention as defined by the ap-

pended claims.

DETAILED DESCRIPTION OF INVENTION

[0007] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout.

[0008] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents that fall within the scope of the appended claims will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0009] Figure 1 shows in side partial sectional view an embodiment of a downhole tool 10 deployed in borehole 12. In the example of Figure 1, borehole 12 intersects a subterranean formation 14, where the downhole tool 10 is used for acoustically interrogating the formation 14 from within borehole 12. Included on the body of the downhole tool 10 is a transmitter 16 shown generating acoustic waves 18 that propagate from the tool 10, through borehole 12, and into the formation 14. Some of the acoustic waves 18 reflect from within the formation 14, and propagate back to acoustic receivers 20, shown provided on a part of the tool 10 different where the transmitter 16 is located. The acoustic sensors 20 sense and record the waves 18. As is known, analyzing the waves 18 can yield information about the formation 14; such as the presence and/or amount of hydrocarbons in the formation 14.

[0010] An example of an acoustic attenuator 22 is shown included with the tool 10 and disposed between the transmitter 16 and receivers 20. Further in the example of Figure 1, the downhole tool 10 is deployed on a wireline 24 in the borehole, wherein optionally the wireline 24 can be coiled tubing or any other conveyance means for lowering and raising a tool within the borehole 12. Further shown is a wellhead assembly 26 at the opening to the wellbore 12 and on surface 28. As shown, wireline 24 is threaded through the wellhead assembly 26 from surface and into the wellbore 12.

[0011] Figure 2 provides a side sectional view of an example of the acoustic attenuator 22, which is shown as having a bore 30 that extends therethrough and substantially aligned with an axis AX of the attenuator 22. Also provided in Figure 2 are attenuation elements 32, which as shown in perspective view in Figure 3, are generally elongate elements. Attenuation elements 32 have opposing ends 34, a portion of each of which approximates a spherical shape. The mid portion 36 of the attenuation element 32 of Figures 2 and 3 has an outer radius that is about the same as the radius of each of the ends 34 from the axis AX. The radius of the attenuation element 32 decreases between the mid portion 36 and each of the spherical ends 34 to define profiles 37 between these portions of the attenuation element 32. In the example of Figure 2, each profile 37 has a generally curved shape from its low point and up to the maximum radius portions of each end 34. Whereas the profile 37 increases generally linearly from its low point and to the maximum radius region of the mid portion 36. Keyholes 38 are shown formed radially inward into the attenuation element 32 and from an outer surface of the ends 34.0

[0012] Referring back to Figure 2, an anti-rotation pin 40 is shown having a radially inward projecting end that projects into the keyhole 38. An end the anti-rotation pin 40 distal from keyhole 38 is illustrated coupled with a sleeve 42; where sleeve 42 circumscribes respective ends 34 of two adjacent attenuation elements 32. In the example of Figure 2, inserting the anti-rotation pins 40 through the sleeves 42 and into the attenuation elements 32 limits relative rotation of attenuation elements 32. Openings 44 are provided in the sleeve 42 to allow insertion of the anti-rotation pins 40. Referring now to Figure 4, a perspective view of the sleeve 42 is shown having the openings 44 formed through its sidewall, and a main bore 46 extending axially through the sleeve 42. A ridge 48 is shown within bore 46 and projects radially inward from the outer surface of the bore 46 and proximate an axial mid portion of the sleeve 42. Further in the embodiment of Figure 4 are threads 49 formed in the bore 46 and at the outer axial portions of sleeve 42.

[0013] Lock rings 50 are shown inserted in spaces between sleeves 42 and outer peripheries of ends 34. As explained in more detail below, the lock rings 50 in combination with the sleeves 42, are used for coupling together adjacent attenuation elements 32. Referring back to Figure 2, lateral sides of lock rings 50 abut shoulders 51 in sleeves 42 that are defined where the radius of the bore 46 reduces and projects radially inward. As shown in perspective view of Figure 5, each lock ring 50 is made up of C-shaped halves 52, 54 that when joined as shown form an axial bore 56 through the lock, ring 50. Bore 56 tapers radially inward from a lateral side 57 and defines an oblique surface. As shown in Figure 2, a portion of the oblique surface is in contact with the outer radial surface of the end 34 of attenuation element 32. Strategically profiling the outer surface of end 34 and bore 56 defines a contact interface 58 between lock ring 50 and attenuation element 32. In one example the contact interface extends along a curved path, and may optionally circumscribe axis AX, thereby forming a continuous loop. Referring back to Figure 1, an advantage of limiting contact between the element 32 and lock ring 50 to a thin contact interface 58 is that the communication path that extends

directly between the transmitter 16 and receiver 20 has a significantly reduced cross-sectional area. Reducing the cross-sectional area of the acoustic communication path between the transmitter 16 and receivers 20 significantly attenuates the acoustic signal between the transmitter 16 and receivers 20.

[0014] Referring back to Figure 2, an annular lock nut 60 is shown connected via a threaded connection 62 to the openings of each sleeve 42. An axial end of each lock nut 60 is in contact with a side of lock ring 50 opposite its lateral side 57, thereby axially retaining the lock ring 50 in its place as shown, and in contact with the ends 34 and the attenuation elements 32. Further in the example of Figure 2, an axial gap 64 is shown between adjacent attenuation elements, wherein in one example wellbore fluid fills the gap 64 thereby enhancing the attenuation capabilities of the acoustic attenuator 22. Optionally, a tube 60 may be inserted into gap 30, and filled with an oil, which in one example may be dielectric. As such, wires 68 can be inserted into the tube 66 and reduce the risk of electrical shorting due to the presence of the dielectric fluid.

[0015] Figure 6 illustrates in perspective view an assembled example of the acoustic attenuator 22 wherein ends 34 of an attenuation element project axially outward from lock nuts 60 shown threadingly engaged with oppositely located sleeves 42 on the acoustic attenuator 22. In one non-limiting example of operation, the presence of the series of acoustic elements 32 within the acoustic attenuator 22 severely attenuates any waves 18 that may attempt to propagate along the body of the tool 10 so that acoustic events sensed by the receivers 20 can be isolated to those waves 18 that reflect from the formation 14 rather than propagating lengthwise across the body of the tool 10.

[0016] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the present invention as defined by the appended claims.

Claims

1. An acoustic tool (10) for imaging in a subterranean wellbore, the tool comprising:

   an acoustic transmitter (16);
   an acoustic receiver (20) spaced axially away from the transmitter (16);
   an elongate attenuation element (32) that is between the transmitter (16) and receiver (20), and that is inserted into an open end of a sleeve (42);
   a communication path defined by a transmission of acoustic signals between the transmitter (16) and receiver (20); and
   a lock ring (50) that contacts the end of the attenuation element (32) such as to retain the end in the sleeve (42);

   characterised by:
   a contact interface (58) between the lock ring (50) and the attenuation element (32) that follows a curved route, is in the communication path, and that defines a reduction in cross sectional area of the communication path; and
   wherein the attenuation element (32) comprises an end that is spherically shaped.

2. The tool of claim 1, wherein the end of the attenuation element (32) comprises a first end (34), the attenuation element (32) further comprising a second end (34) that is rounded and inserted into an open end of a sleeve (42), the tool further comprising a multiplicity of attenuation elements (32), a multiplicity of sleeves (42) and lock rings (50) for coupling the attenuation element (32) in series, and thereby forming a multiplicity of contact interfaces (58) that each attenuate acoustic signals that propagate along the communication path.

3. The tool of claim 1 or claim 2, further comprising an oil filled tube (60) inserted into a bore that extends axially through each of the attenuation elements (32), and lines in the tube that selectively couple with the transmitter (16) and receiver (20).

4. The tool of any one of the preceding claims, wherein the lock ring (50) spaces the sleeve (42) radially away from the attenuation element (32).

Patentansprüche

1. Akustisches Werkzeug (10) für eine Bildgebung in einem unterirdischen Bohrloch, das Werkzeug umfassend:

   einen akustischen Sender (16);
   einen akustischen Empfänger (20), der axial weg von dem Sender (16) beabstandet ist;
   ein längliches Dämpfungselement (32), das sich zwischen dem Sender (16) und dem Empfänger (20) befindet und das in ein offenes Ende einer Hülse (42) eingesetzt ist;
   einen Kommunikationspfad, der durch eine Sendung akustischer Signale zwischen dem Sender (16) und dem Empfänger (20) definiert ist; und
   einen Verriegelungsring (50), der das Ende des

Dämpfungselements (32) berührt, wie um das Ende in der Hülse (42) zu halten;
gekennzeichnet durch:
eine Kontaktschnittstelle (58) zwischen dem Verriegelungsring (50) und dem Dämpfungselement (32), die einer gekrümmten Route folgt, sich in dem Kommunikationspfad befindet und die eine Verringerung der Querschnittsfläche des Kommunikationspfads definiert; und wobei das Dämpfungselement (32) ein Ende umfasst, das kugelförmig geformt ist.

2. Werkzeug nach Anspruch 1, wobei das Ende des Dämpfungselements (32) ein erstes Ende (34) umfasst, das Dämpfungselement (32) ferner umfassend ein zweites Ende (34), das abgerundet und in ein offenes Ende einer Hülse (42) eingesetzt ist, das Werkzeug ferner umfassend eine Vielzahl von Dämpfungselementen (32), eine Vielzahl von Hülsen (42) und Verriegelungsringen (50) zum Koppeln des Dämpfungselements (32) in Reihe, und wobei dadurch eine Vielzahl von Kontaktschnittstellen (58) ausgebildet werden, die jeweils akustische Signale dämpfen, die sich entlang des Kommunikationspfades ausbreiten.

3. Werkzeug nach Anspruch 1 oder 2, ferner umfassend ein ölgefülltes Rohr (60), das in eine Bohrung eingesetzt ist, die sich axial durch jedes der Dämpfungselemente (32) erstreckt, und Leitungen in dem Rohr, die mit dem Sender (16) und dem Empfänger (20) wahlweise gekoppelt sind.

4. Werkzeug nach einem der vorstehenden Ansprüche, wobei der Verriegelungsring (50) die Hülse (42) radial weg von dem Dämpfungselement (32) beabstandet.

Revendications

1. Outil acoustique (10) destiné à l'imagerie dans un puits de forage souterrain, l'outil comprenant :

un émetteur acoustique (16) ;
un récepteur acoustique (20) écarté axialement de l'émetteur (16) ;
un élément d'atténuation allongé (32) qui se trouve entre l'émetteur (16) et le récepteur (20), et qui est inséré dans une extrémité ouverte d'un manchon (42) ;
une voie de communication définie par une transmission de signaux acoustiques entre l'émetteur (16) et le récepteur (20) ; et
un anneau de verrouillage (50) qui vient en contact avec l'extrémité de l'élément d'atténuation (32) de manière à retenir l'extrémité dans le manchon (42) ;
caractérisé par :
une interface de contact (58) entre l'anneau de verrouillage (50) et l'élément d'atténuation (32) qui suit une trajectoire incurvée, est dans la voie de communication, et qui définit une réduction de la surface de section transversale de la voie de communication ; et dans lequel l'élément d'atténuation (32) comprend une extrémité qui est de forme sphérique.

2. Outil selon la revendication 1, dans lequel l'extrémité de l'élément d'atténuation (32) comprend une première extrémité (34), l'élément d'atténuation (32) comprenant en outre une seconde extrémité (34) qui est arrondie et insérée dans une extrémité ouverte d'un manchon (42), l'outil comprenant en outre une multiplicité d'éléments d'atténuation (32), une multiplicité de manchons (42) et d'anneaux de verrouillage (50) permettant de coupler l'élément d'atténuation (32) en série, et formant ainsi une multiplicité d'interfaces de contact (58) qui atténuent chacune des signaux acoustiques qui se propagent le long de la voie de communication.

3. Outil selon la revendication 1 ou la revendication 2, comprenant en outre un tube rempli d'huile (60) inséré dans un alésage qui s'étend axialement à travers chacun des éléments d'atténuation (32), et des lignes dans le tube qui se couplent sélectivement avec l'émetteur (16) et le récepteur (20).

4. Outil selon l'une quelconque des revendications précédentes, dans lequel l'anneau de verrouillage (50) écarte le manchon (42) radialement de l'élément d'atténuation (32).

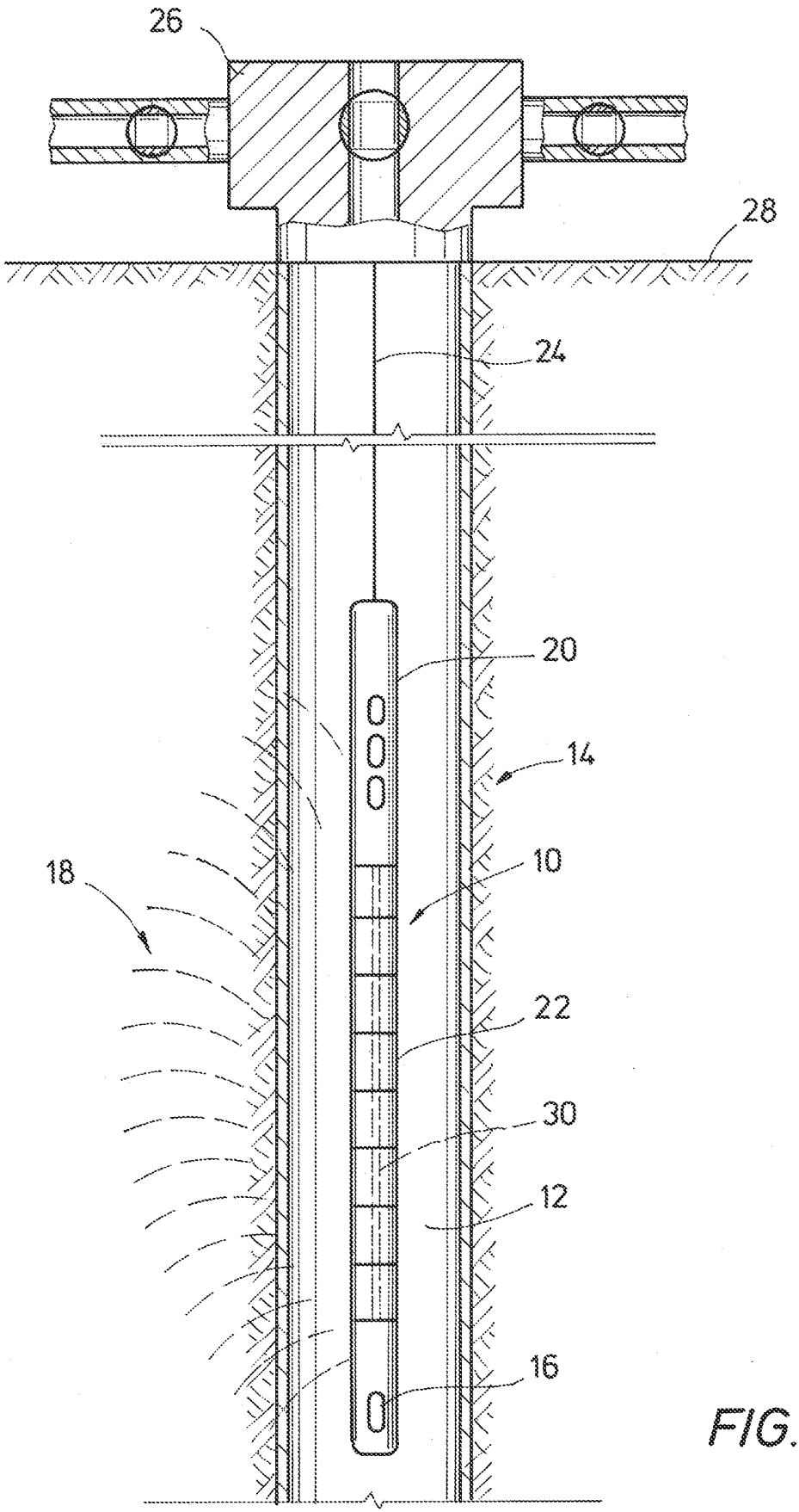

FIG. 1

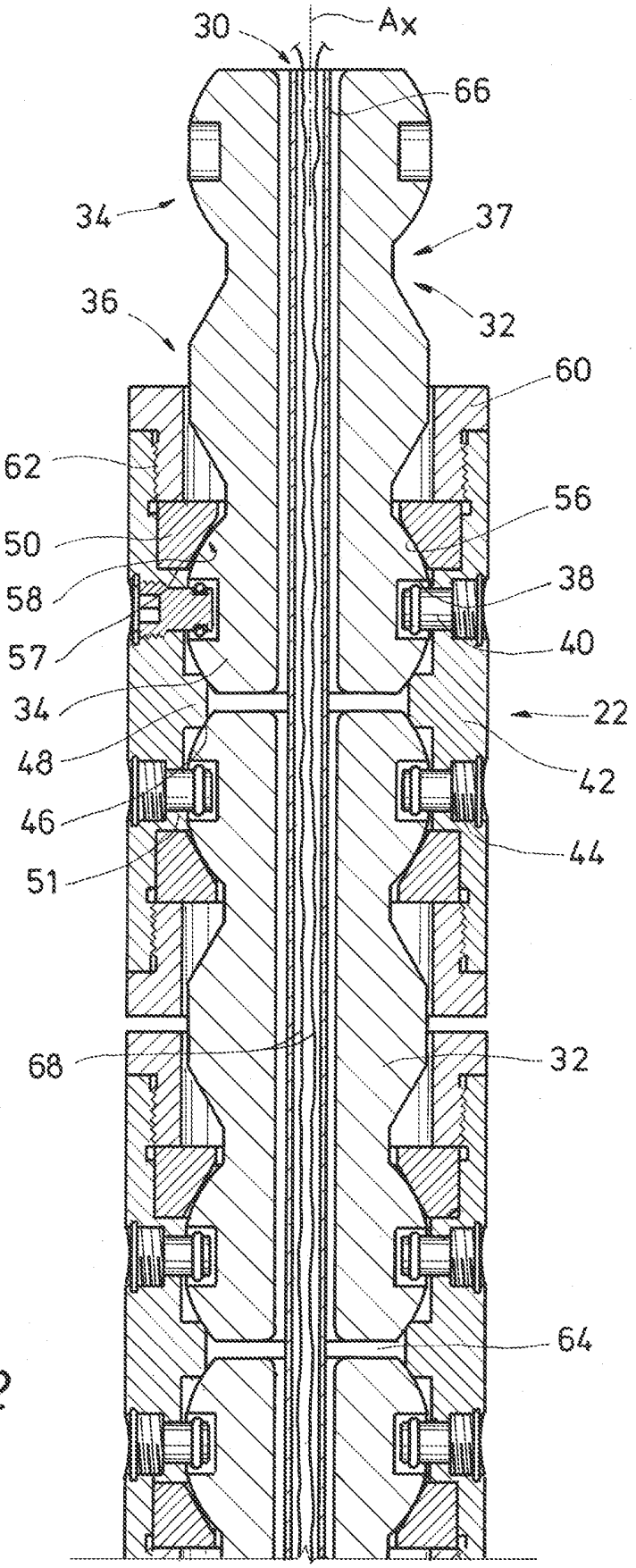
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FIG. 2

FIG.4

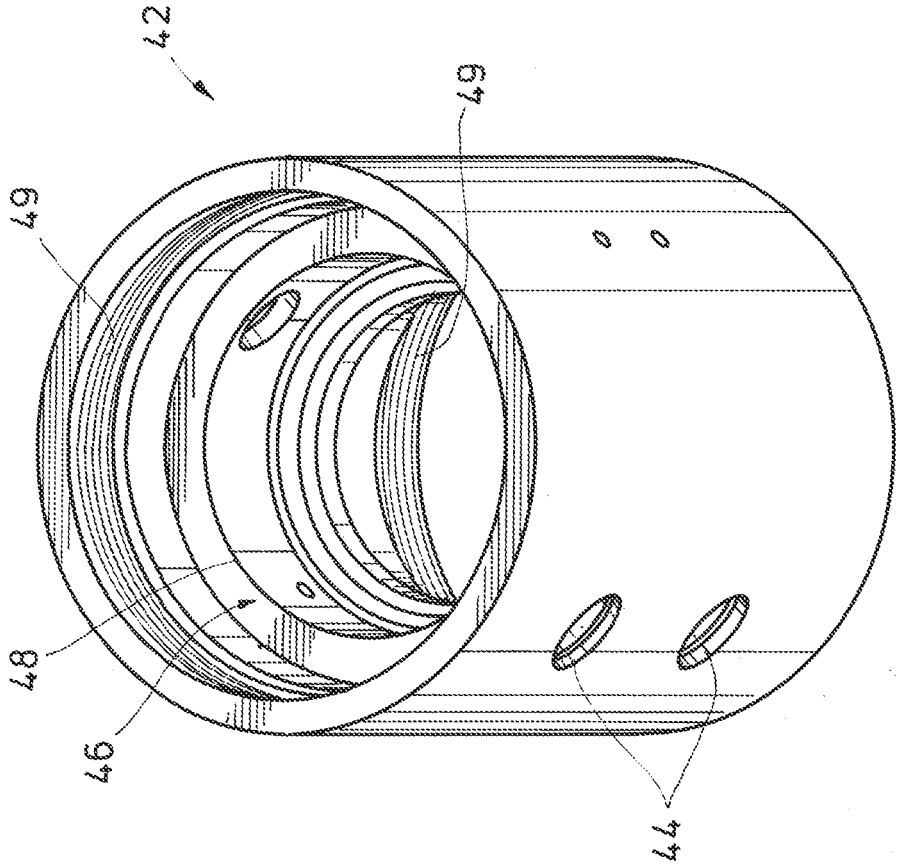


FIG.3

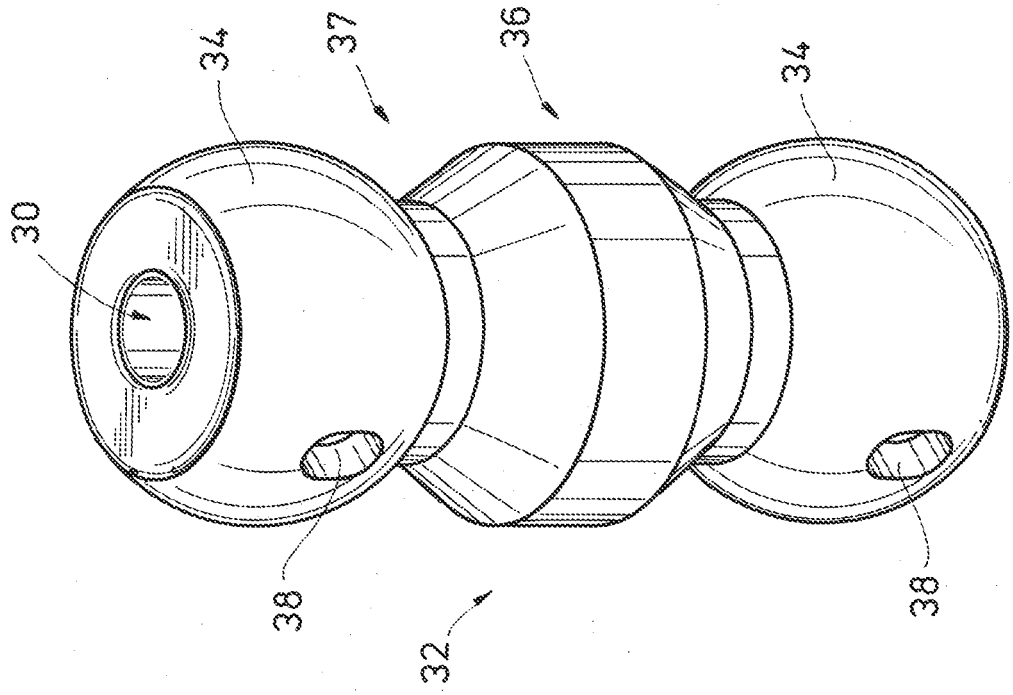


FIG.5

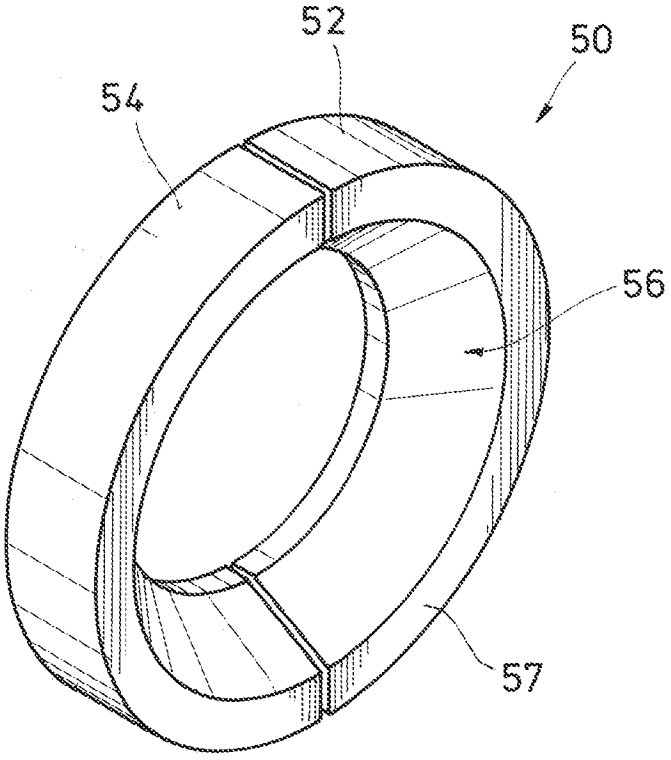
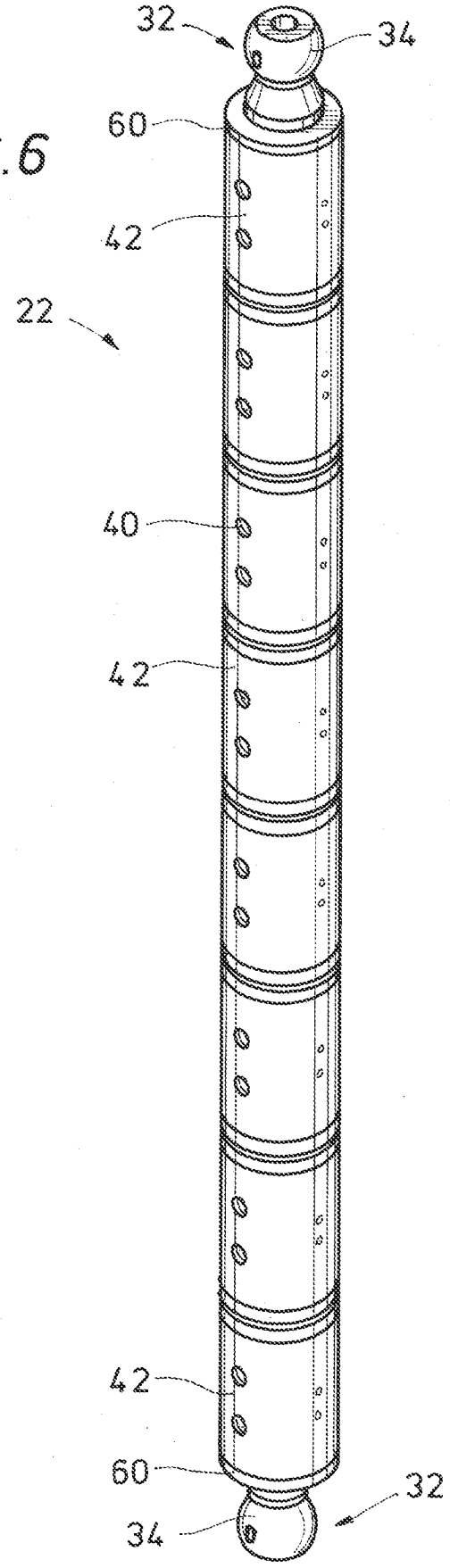


FIG.6



REFERENCES CITED IN THE DESCRIPTION

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